

NIST Develops Reference Materials for Trace Explosives Detection

NIST is developing two Standard Reference Materials that can be used to test and calibrate both field-deployable detectors, such as those used in transportation security, as well as sophisticated laboratory instruments, such as those used for post-blast forensic investigations. SRM 8106 Trace Solution Explosives will address the low-level calibration of explosives detectors and RM 8105 Trace Particulate Explosives will be used to evaluate the collection and testing of explosives particles.

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An important tool to protect against terrorist explosives events is the sensitive and accurate measurement of residues transferred by the handling and fabrication of improvised explosives devices. Currently there are no NIST certified reference materials specifically addressing trace explosives analysis. Commercial solutions of explosives are only available at high concentrations and are not suitable for trace detection evaluations. Solutions cannot be used to test and validate the performance of the entire residue detection protocol, including particle collection and transfer of the characteristic compounds into the instrument prior to the measurement.



The challenge is to create reference materials that will provide calibrated trace amounts of two compounds (TNT and RDX) that are commonly used in plastic and military explosives in a form that is safe to handle. Using these reference materials, customers will be able

to test and calibrate a wide variety of trace explosives detection equipment.

This work is part of a larger effort by the Department of Homeland Security to promote standardization for critical measurements. RM development is a collaborative effort with the Surface and Microanalysis Division at NIST, who are investigating the properties of explosives residues and testing the performance of field-deployable explosives detection systems. This project builds on our previous research in analytical methods that support the forensic investigation of improvised explosive devices prepared using gunpowder, which resulted in the development of RM 8107 Additives in Smokeless Powder.

In the past year, seven candidate materials for the Trace Particulate Explosives material were prepared and evaluated. Candidate materials were selected to provide high thermal stability and appropriate particle size for representing explosives residues. To fabricate the candidates, the active ingredients of the plastic explosive C4 (containing RDX) and TNT were dissolved in organic solvent and

coated onto a series of inert substrates. The solvent was removed under vacuum using a rotary evaporator, leaving trace amounts of the explosives coated on the inert substrates. Once prepared, each candidate material was extracted, and the explosives content determined by liquid chromatography. To investigate the stability of each candidate material upon storage, subsamples were stored at five temperatures between -20°C and 70°C and analyzed over a two-month period. Candidate materials were further evaluated using the most commonly deployed detection system for trace explosives detection, ion mobility spectrometry. From these experiments, a single "best candidate" substrate has been selected – porous silica beads with a bonded hydrocarbon coating. We are currently preparing 1 kg of the RM candidate.

NIST trace explosives reference materials will provide customers with well-characterized materials to strengthen detection technology: from manufacturers of current technology and their users, to developers of next-generation technology.

Prototype materials for the Trace Solution Explosives SRM have also been prepared and tested. The concentrations of these solutions have been chosen so that a single drop will contain sufficient explosive to provide a minimal positive 'alarm' signal with the most commonly deployed explosive detectors. This solution SRM will support the upcoming ASTM "Standard Practice to Verify Minimum Acceptable Performance of Trace Explosives Detectors." Development and promotion of this work within the ASTM Committee E54 Homeland Security Applications has been a collaborative effort of the Surface and Microanalysis Division, Analytical Chemistry Division, and the NIST Office of Law Enforcement Standards.

Future Plans: The certification of the reference materials for RDX and TNT should be complete by the end of FY07. In future years, we may develop a series of reference materials encompassing an array of ingredients used in the fabrication of improvised explosive devices.

Publications: MacCrehan, W. "Development of a NIST Trace Particulate Explosives Reference Material to Evaluate IMS Detectors," *International Journal for Ion Mobility Spectrometry*, in press.